VERTEBRATE INVENTORY AND MONITORING

FOR PUEBLO COLORADO WASH,

HUBBELL TRADING POST

NATIONAL HISTORIC SITE

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SUMMARY

We conducted Mammal, bird, reptile, and amphibian surveys along Pueblo Colorado Wash at Hubbell Trading Post National Historic Site during February, May, July, and September, 2002. These surveys were made in conjunction with ongoing stream improvement and exotic vegetation removal programs at the site. We failed to catch any small rodents in 104 trap-nights using Sherman live traps. Mid-sized mammals documented for the site were rock squirrel, striped skunk, gray fox, raccoon, coyote, domestic cat, domestic dog, and mule deer. We did not survey bats.

We counted 66 bird species on the survey routes and an additional 6 species off-routes. May surveys yielded the highest diversity with 42 species, followed by September with 31 identified, July with 25, and February with 20. The May and September surveys yielded the greatest diversity of birds, while winter and spring counts yielded the greatest number of individual birds using the area. The highest density of birds for any single day occurred during the winter surveys, with an estimate of 108.6 birds/ha. No owls were recorded on the area.

We found 4 lizard, 2 snake, and 2 toad species on the site.

Four species noted occur on endangered species or species of concern lists: kit fox, Lucy's warbler, greater roadrunner, and sagebrush lizard. We did not confirm presence of kit fox, but found small canid tracks that fell within its size range. Lucy's warbler occurred as a fall migrant; the other species are resident to the Ganado area.

Problems in survey methodology are discussed in this report and a recommendation made that a plan stating clear objectives for wildlife habitat management be developed that is congruent with the historic preservation goals of Hubbell Trading Post.

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INTRODUCTION

In 1997, the National Park Service began restoration of Pueblo Colorado Wash, with consideration given to historic, ecological, esthetic, scenic, recreational, and flood control benefits. This stream reconstruction used hand-made structures of naturally occurring materials gathered on-site. The method, called induced meandering, uses the power of flowing water in the stream to create new meanders in the channel. Stream characteristics are measured and photographed with 25 views from 13 permanent photo points reshot periodically. Water quality is monitored by the Navajo Nation Environmental Protection Agency. Details of this project are provided in *Demonstration Enhancement of Pueblo Colorado Wash,* Hubbell Trading Post National Historic Site (HTP) Grant No. 97-029WPF, June 2001.

Concurrent with the stream structural improvement, exotic plant species were removed from the area by the NPS Exotic Species Removal Team. All Russian olive and tamarisk within approximately 20 acres surrounding the streambed were cleared and treated during 1997, 1998, and 1999.

Vegetation plantings that have been carried out to date include transplants of American three square (*Scirpus americana*) on the edges of the stream meander control structures to reduce erosion and plantings of cottonwood (*Populus* sp.) and willow (*Salix* sp.).

A vegetation monitoring program has been established, using measurements of foliage height density of perennials and percent cover of annuals along line intercept transects. Photo points were established in conjunction with the line transects. Baseline

measurements of vegetation were completed in 1998 (Baker 1998). These measurements and photo points were repeated in August 2001 and 2002.

The vertebrate inventory reported here was developed to gather baseline information on occurrence and abundance of vertebrate species within the stream improvement area. Questions addressed by the initial inventory are:

1. What mammalian, avian, reptilian, and amphibian species are present within the stream improvement area?

2. What is the relative abundance of the above species within the stream improvement area?

Sampling was carried out using methodology that will allow future surveys to test the null hypothesis of no change in vertebrate species composition or abundance resulting from regrowth of the streamside habitats.

STUDY AREA

This inventory focused on the portion of Pueblo Colorado Wash that is within the boundary of HTP National Historic Site (Figure 1). Length of this stream segment is approximately 880 meters. The bottomland and alluvial banks of the stream encompass approximately 6.4 ha. Elevation of the stream is about 1930 meters. Brown and Lowe (1980) classify the vegetation as Great Basin desert scrub.

HTP has an arid climate with an average of just less than 11 inches of precipitation per year. About 60 percent of the precipitation occurs between early July and late October, with the remainder of annual precipitation falling during cyclonic winter storms. Most winter precipitation falls as snow. The driest months are May and

June. The year preceding the surveys was one of the driest on record for northeast Arizona (Figure 2), falling below 25.4 cm (10 in.) total precipitation between July 1, 2001 and June 30, 2002. Only 7 other years have fallen below this level in the past 107 years in this region. The site is characterized by moderate summers, with high temperatures ranging into the nineties in July and cold winters, with sub-zero temperatures common in January (Sellers and Hill, 1974).

Little information exists regarding historic wildlife populations for the site. Faunal analysis for the Wide Reed Ruin excavation, dating to approximately AD 1276, found remains of black-tailed jackrabbit[1], cotton-tailed rabbit, mule deer, pronghorn, wild turkey, ground squirrels, wild or domestic canids, cotton rat, bobcat, white-throated woodrat, and wild turkey. Remains of cottontails were most abundant, followed by jackrabbit, mule deer, and wild turkey. With the exception of the pronghorn and cotton rat, all of the above species exist today within a radius of 20-25 miles of the trading post. HTP is well outside of known historic or present range of the cotton rat, suggesting that occupants of the pueblo may have imported the single specimen detected. Lacking from remains were coyote-fox types or riverine mammals, such as raccoon. Also lacking were aquatic vertebrates (Treadwell and Mount, 1993; Olsen and Olsen, 1993).

Pollen analysis for the Wide Reed Ruin (Schoenwetter, 1993) shows a conspicuous lack of riparian species and relatively high count of ponderosa pine (*Pinus ponderosa*), which grows at higher elevations away from the site today. E. W. Nelson, in 1909, noted about 100 ponderosa pines growing along the road leading *westward* from

[1] Scientific names of animals and plants mentioned in the text are listed in Appendix tables A, B, and C.

Ganado (E. W. Nelson, unpubl. field notes, Smithsonian). He did not say how far this stand of trees was from Ganado.

On May 20, 1858, Lieutenant Joseph C. Ives (1861) camped on Pueblo Colorado creek in the general vicinity of the present site of HTP. He described Pueblo Colorado as "a pretty creek running between steep earth banks ten or twelve feet high." He noted that the water is good, but warm. The surrounding landscape, he described as "…an extensive and lovely valley, a brilliant sheet of verdure dotted with clumps of cedars…" He mentioned no riparian vegetation nor did he discuss species of wildlife in the area but noted that "Countless herds of horses and flocks of sheep were grazing upon the plain." His Hopi guides told him that this was one of the most thickly populated sections of the Navajo territory. He also noted that "Hundreds [of Navajos] have come into camp".

Froeschauer-Nelson (1998) provided few records of wildlife at HTP after its development in 1878. She quoted Dorothy Hubbell in noting that the Hubbell family at one time had a pet badger and at another, a bobcat. She also noted that they had turtles from time to time and that they kept a bull snake in the wareroom to get mice. She did not say if any of these pets were captured on the Hubbell site.

In 1909, E. W. Nelson noted that prairie dogs were common near Ganado. He also stated that pronghorn had been virtually extirpated from the entire Navajo Reservation by this time (E. W. Nelson, unpublished field notes, Smithsonian).

METHODS

Our purpose was to establish a baseline inventory of birds, mammals, reptiles, and amphibians on the stream improvement and riparian vegetation treatment area. No formal wildlife inventory data are available for the site prior to the beginning of treatment. This inventory was established five years after the vegetation and stream treatments were begun. However, vegetation recovery has not progressed much beyond the fairly open conditions created by the initial exotic vegetation removal and stream structure improvement. As a result, vertebrate monitoring established at this time will provide an approximation of the immediate post-treatment conditions.

Fish and other aquatic vertebrates were not included in this inventory. John Rinne of Rocky Mountain Forest and Range Experiment Station identified two exotic fish species, fat head minnows and zebra tips, at the beginning of the treatment period (Bill Zeedyke, personal communication 2001). Subsequent monitoring of fish populations will depend upon the degree to which stream depth and stability develops in the future.

No effort was made to inventory bats. While the stream is used by bats as a feeding area, adequate determination of species would require a combined approach of intensive netting over the stream and sonic recording of calls. Bat roosting areas on the HTP, if any, undoubtedly occur in barns and other anthropogenic structures or in the larger trees.

We contacted the U. S. Fish and Wildlife Service Office of Endangered Species, the Arizona Game and Fish Heritage Program, and the Navajo Nation Fish and Wildlife Department regarding wildlife species of concern. The Arizona Game and Fish Department Heritage Data Management System shows no Special Status Species or

critical habitats for the study site. No federally listed mammal is shown for the study site. Two Navajo Nation listed mammalian species are possible for the site, along with three species from their element tracking list. No federally or Navajo Nation listed reptile is probable for the site, but at least four species from the Navajo Nation element tracking list might be present. At least two federally-listed bird species are possible for the site, and at least nine Navajo Nation endangered birds and 27 species from their element tracking list could use the site for migratory or wintering habitat.

Inventory

This inventory focused on the portion of Pueblo Colorado Wash undergoing stream improvement. The NPS, through the Colorado Plateau Cooperative Ecosystem Studies Unit at Northern Arizona University has contracted with the Navajo Nation Heritage program to inventory the remainder of the HTP. We have contacted David Mikesic of the Navajo Nation Wildlife Department and will provide him with the results of our efforts for inclusion into his broader site inventory.

In developing this project, we also contacted Ann Culley and Michael Brittain of the Colorado Plateau Ecosystem Studies, who recommended inventory protocols (Proposal and Task Agreement, Colorado Plateau Cooperative Ecosystem Studies Unit and Northern Arizona University, 2000). As a result of those discussions, we accessed the National Park Service Inventory and Monitoring web page (http://www.nature.nps.gov/im/monitor/) which led to several useful documents (Fancy, 2000; Rosen and Lowe, undated; Johnson, 1995; Petryszyn, 1995) regarding NPS monitoring protocol. Our sampling methods are largely adaptations of these various protocol.

We focused inventory efforts into four sampling periods within a single year so that 1) breeding bird surveys could be conducted at least twice during the period from mid-May to mid-July in order to assure that a high percentage of nesting species have been detected; 2) winter resident birds could be surveyed in mid-winter, and fall migratory birds could be surveyed during early fall; and small mammal survey efforts could be conducted in early July. We decided that post-treatment vegetation recovery was progressing too slowly for significant change to take place in two sequential years, hence our efforts would be better spent in establishing a solid single-year baseline that can then be repeated at appropriate times, after a significant change in vegetation has occurred.

Mammals

Small nocturnal mammals. Sampling for small mammals was conducted the nights of July 18 and 19, 2002. The site was sampled using transects stakes already established for the streamside vegetation surveys (Figure 1; Baker, 1998). Advantages of using these transects were 1) they are already marked, hence the clutter of additional markers on HTP will not be needed; 2) small mammal data will automatically be linked to vegetation data, providing opportunity to identify relationships between future vegetation change and small mammal population change; 3) they provide permanent repeatable transects as recommended in the NPS sampling guidance (Fancy, 2000). A disadvantage may be that the transects are not randomly selected. However, this sampling strategy will yield valid within site, between year, comparisons, which are the only comparisons required by this monitoring program. Thirteen of these vegetation transects were established along the intermittent stream channel. Transects are paired on

each side of the wash, except in one case, where the site boundary was too close to the channel. For small mammal sampling, we used all 13 transects. Starting points of transects were established systematically at 100 m intervals along the channel. Transects are situated at least 40 m from the historic site boundary to avoid boundary effects. Starting points are marked with 0.5 inch (1.27 cm) rebar at a point 20 meters bankside from the water's edge or the outer edge of wetland graminoids.

Trapping was done with Sherman live traps placed at each end of the 20 meter transect perpendicular to the stream. Two traps were set near each sample point, yielding a total of 26 sample points and 52 traps. Insofar as possible, traps were placed to take advantage of morning shade, thereby reducing chances of rodent mortality. Traps were maintained for two nights and checked at first light each morning.

Small diurnal mammals. Small diurnal mammals were surveyed in conjunction with the reptilian time constraint surveys described below and were recorded on the forms used for the lizard surveys. Sign or observations of small mammals was also noted during bird surveys.

Mid-sized and large mammals. All sign or sightings of mid-sized and large mammals, such as raccoons, foxes, coyotes, or deer observed during other survey activities on the site were recorded. A remote sensing camera (Deer Cam) was set near the chicken pen in an effort to record small carnivores.

Birds

Breeding birds were surveyed on February 4 and 5; May 17 and 20; July 15 and 16; and September 8 and 9, 2002. We used distance sampling along two approximately 820 meter linear transects. These transects ran parallel to the stream at approximately 20

m from the thalweg and were traversed slowly starting ½ hour after sunup. Ending time depended upon the number of birds seen and time required in making identification. Birds were identified visually or by song. For each new bird observed, distance to the bird from the observer and angle from the transect was recorded. Distance was measured as closely as possible with an optical rangefinder. Angle from the transect was measured with a lensatic compass. Each transect was surveyed for two mornings, alternating the end of the transect where the survey began.

In addition to birds recorded on the formal survey, any birds seen incidental to other activities on the study site were also recorded and included in the total species list for the site. Efforts were made to note nocturnal calling birds during the nighttime reptile and amphibian surveys.

Reptiles and amphibians

Line transects. Diurnal reptiles were surveyed on May 18 and 19 and July 17 and 18, 2002. We were unable to make the planned September reptile surveys due to cool temperatures and heavy rains. We used an adaptation of the standardized lizard line (SLL) transect described by Rosen and Lowe (1995). This technique involved walk-line transects standardized for recording all observed lizards in a 15-m-wide (49-ft) belt, 7.5 m (24.6 ft) on either side of the walked midline. Transect length averaged 820 meters. Lines were walked 2 times during a day on two successive days beginning at or prior to the emergence of diurnal lizard species. We waited for air temperatures of 80° Farenheit before beginning a route.

The walks during the course of one day comprised a run. The primary data points generated during a run are the maximum number of lizards observed during any single

walk, for each species. These species maxima are termed the peak values: they represent the best estimate for abundance of each species on the line at run-time. The sum of peaks over all species is the total estimated lizard abundance.

Rosen and Lowe's protocol recommended that proper time spent on the line during individual walks of a run by the field worker average 9–11 min/100 m on the earlier runs when small lizards are active and basking is observed, and 7–9 min/100 m in later runs. Individual field workers may deviate from these averages by up to 2 min as a result of differences in eyesight, hearing and experience. Because of an extremely low density of lizards and the open habitat, we found that we moved across the transects at a higher rate, averaging 5.7 min/ 100 meters. Rate of travel was slower during runs when lizards were active due to extra time taken to view and identify individual lizards. The initial run on May 18, 2002 was covered at a rate of 8 min/100 meters.

Data were recorded on each run included cloud cover, wind, air temperature, substratum temperature, starting time, and ending time. Data recorded for each lizard observed on the transect included species, time, distance along transect, distance away from midline, size, and behavior.

Nighttime spotlight and listening point samples. Two nighttime survey routes were run during the May, July, and September periods. Surveys started one hour after sunset and continued until the survey route was finished. The survey routes encompassed the length of the stream within the HTP site and ran parallel to the stream on each side at about 7.5 m distance from the thalweg. Routes were run slowly while the ground was scanned carefully with headlamps for snakes or amphibians. We initially listened for 10 minutes at 50-meter intervals for amphibian and nocturnal bird calls. However, the small

area of the study site made such intensive call sampling impractical. Any amphibians calling could be heard over the entire site. As a result, we modified the methodolgy to listen for 5 minutes at 200 meter intervals, thereby focusing our efforts more on visual searches. At the end of each search along the stream for amphibians, a more general return search along the uplands was made for nocturnal snakes.

Data analysis

Data were summarized from field data sheets and entered into Excel spreadsheets. Initial population parameters calculated include a population index for each species and species richness and species diversity for the area. These indices have minimal value as single-year values but will assume increasing value over time in detecting changes as the monitoring surveys are repeated.

Population indices. This is the actual number of individuals of each species captured or observed during the survey period per survey unit. Although it does not represent all animals actually present in the area, it is adequate for comparing fluctuations within the system. For mammals this is the number of individuals/species captured per trap night. For birds, it is be the number of individual birds/species/transect run. A breeding bird density estimate was derived from the distance-measure transects.

For birds, we also calculated a cumulative relative abundance figure. This datum represents the highest number of each species seen on a single run during each survey period. The study site was small , and formal survey routes overlapped with each other. The surveys amounted to near total coverage of the site. As a result, we consider relative abundance, rather than estimated densities, to be the best number for annual comparisons of bird population trends on the area.

For reptiles, peak values (maximum number observed in any single walk), for each species, were read directly from the data forms. A total peak value was derived for reptiles by summing the peak values for all species. Lizard densities were calculated for each run using two estimates of strip width. One estimate was based upon the 15-meter strip width recommended in the survey protocol. A second estimate was made using a strip width based upon vertical sighting distance for lizards seen. This second average strip width was smaller than the standard 15-meter width and therefore yields a higher estimate of lizard density. It is probably more closely representative of true densities of lizards on the area.

Species richness. This is the total the number of species observed or occurring in a given area.

Species diversity. Known as Shannon's H, this quantifies the degree of evenness in the abundance values for the species on a site or in a sample. High species diversity indicates that many of the species occur in subequal abundances, while low species diversity indicates that a single or a few species are numerically dominant. H is calculated by the following formula:

$$H = -SUM\ (p_i\ LOG\ p_i)$$

where p_i is the proportion of total individuals falling within species$_i$ divided by the total individuals of all species, and *LOG* is natural logrithms.

RESULTS

Mammals

We failed to catch any small mammals in 104 trap nights of effort in mid-July. This result was in keeping with our general observations on the site. With the exception of rock squirrel burrows, we found few freshly used rodent holes or runs within the treated area. This low population of small mammals is probably a result of the drought conditions preceding the July mammal survey period, predation by domestic and native predators, and depletion of vegetation during the treatment period.

Mammals seen or documented via tracks and sign on the area include rock squirrel, striped skunk, gray fox (a gray fox was hit by a car on HTP in February, 2001. Cf. Memorandum to Nancy Stone from Scott Bender, DVM dated 4 June, 2001), raccoon, coyote, domestic cat, domestic dog, and mule deer. Mule deer were using Pueblo Colorado Wash nightly during July, probably due to the extended drought. The wash was one of the few sources of water and green vegetation in the area . A track of what may be a long-tailed weasel was also found and a very small canid track was found that may have been kit fox. While difficult to see, long-tailed weasels are considered to be relatively common on the Navajo Reservation (David Mikesic, personal communication).

Rock squirrels are common on the site, and we documented locations of three dens. We observed a single striped skunk during nighttime amphibian surveys in July. This animal appeared to be suffering from an inverted uterus and had viscera extruding from its posterior area. It probably did not survive. We did not observe gray fox directly but were given reports of gray fox by NPS personnel and found canid tracks on the site

that were of appropriate size for gray fox. The track of a single raccoon was found in the wet stream bed during our July surveys. We observed a single coyote during the July survey. This was an old animal that was hunting in midday. Domestic cats are abundant at the Trading Post and their tracks indicated that they hunted throughout the study site. We frequently observed them or were accompanied by them during night-time amphibian surveys. Similarly, domestic dogs were seen using the area and one frequently accompanied us on surveys.

Our surveys have not included bats, but we noted bats feeding over the wash at night. Also the buildings, especially the older barns and sheds, on the site would make potential bat roosts.

Birds

Sixty-six species of birds were identified on routes during the four survey periods. An additional 6 species were identified on the study site independent of the formal surveys. The May surveys yielded the highest number with 42 species, followed by September with 31 identified, July with 25, and February with 20 (Table 1). The highest density of birds for any single day was found during the winter surveys, with an estimate of 108.6 birds/ha on February 4 if the large flocks of pinyon jays were included, and 56.7 birds/ha if the jays were eliminated from the analysis (Table 2). The May counts yielded the second-highest density with 28.9 birds/ha, followed by the July counts with 28.9 with pinyon jays (20.7 without), and September with a high of 18.1 birds/ha. No large flocks of jays were seen during the spring or fall counts. The spring and fall surveys yielded the greatest diversity of birds, while winter and spring counts yielded the greatest number of individual birds using the area.

Perhaps a more realistic assessment of bird use of the area by season involves the cumulative abundance and relative density figures presented in table 2. Here, the largest number of individuals of a single species seen on a single run during each season (abundance) is divided by the average area surveyed during each season. Using these figures, winter maintains first rank for total bird abundance and density, followed by spring, fall and summer with the large pinyon jay flocks excluded. We excluded these large flocks in comparing seasons, because they ranged over much greater area than the study site but briefly passed through during our morning surveys in both February and July. They greatly distorted the bird totals.

In calculating the Shannon's H diversity index, we included all birds counted (table 2). The high bird species diversity of May was to be expected due to spring migration and active breeding behavior. Fall migration is represented by the somewhat elevated number of species present, especially warblers, during the September survey. In addition to birds observed on the survey routes, we saw Pine siskins in February, Say's phoebe, hairy woodpecker, and a probable prairie falcon in May; Say's phoebe, English sparrow, and white-breasted nuthatch in July, Say's Phoebe and white-breasted nuthatch in September. A list of all bird species seen by season is provided in table 3.

Reptiles

Lizard numbers were relatively low for both survey periods and seemed to be especially scarce in July (Table 4). This could be a result of mid-summer aestivation or, more likely, actually represents a low lizard population. Four species of lizard were recorded on the area during May, but only two of these species were found in July.

As with birds, the density and Shannon's H data will have little importance until future surveys are made, thereby providing numbers for comparison.

Lizard species densities (Table 5) and rates of observation are also provided (Table 6). Species density is based upon a constant survey strip width of 15 meters and an average transect length of 820 meters. A second species density was calculated using average sighting distances, but the extremely low numbers of lizards seen on some surveys caused area estimates to be very small. This resulted in meaningless figures where estimated lizard densities were higher on runs where fewer lizards were counted.

Analysis of data disclosed that surveyors tended to move through the area more rapidly when they were seeing few or no lizards, thus creating a bias in the rate of observation data. This explains the contradictory results between estimated lizard densities and lizard observation rates. Because of this bias, the estimated densities are the best index to relative lizard numbers for these surveys and should be used for comparisons with future surveys.

May counts were higher than those in July, as was species diversity. We cannot speculate on the causes for this. Similarly, lizard densities were consistently higher on the north side of the wash than on the south side. We saw no definite habitat differences that would explain such a difference.

Only two snakes, both black necked garter snakes, were seen in September on the study site. One gopher snake was seen off of the survey routes near the visitor's center in May.

Amphibians

During the May nighttime amphibian surveys, 19 Woodhouse toads were counted along 934 meters of the stream thalweg on May 18. Only a few toads were singing and all of the toads were visually located. On May 19, 16 Woodhouse toads were counted. Toads were hardly calling at all. On both surveys, water had been released upstream, causing the stream to run the width of its bed and about 8 inches deep in most reaches.

On July 16, no toads were seen or heard calling along the 934 meter streambed. The creek was running from evening rains. On July 18 the creek was still running from rains but lower than the night before. Woodhouse toads again were not calling, but we visually counted 5 individuals of this species. We also visually located one New Mexico spadefoot.

We were able to make only one brief evening survey on September 8 due to heavy rains and creek flow. We visually located 6 Woodhouse toads.

DISCUSSION

Small ground-dwelling species and nocturnal raptors appear to be lacking on the treated area. This includes ground-nesting birds, owls, small mammals, lizards, amphibians, and snakes. We would expect an increase in species in all of these categories as ground vegetation recovers and wetter climatic conditions develop.

Mammals

The failure to catch any small mammals in 104 trap nights in July indicates an extremely low density of small mammals within the treatment area at Hubbell. This is probably the result of a combination of extreme habitat modification associated with the

removal of exotic vegetation, the extended drought, and presence of small predators in the form of feral house cats, domestic dogs, raccoons, possibly gray fox and long-tailed weasel, and coyote. We observed few active small mammal holes on the area and virtually no small mammal pathways. We suspect that the extended drought is the prime cause and that the small mammal population will increase if increased precipitation allows ground level vegetation to recover. Pocket gophers (*Thomomys sp.)* were reinvading the treatment area by the time of our September surveys.

Rock squirrels were relatively abundant on the treated area, and were using at least three separate dens in the Pueblo Colorado wash bank. These animals moved throughout the area and were therefore difficult to identify as individuals. In July, when young were first beginning to move around, at least seven individuals were using the treated area. This is a minimum estimate of their numbers.

Because of the poor results of small mammal trapping, these surveys should be repeated during the summer of 2003. We suggest that the sample design attempted during July 2002 be repeated. If results of such a survey are again inadequate, we suggest that the area be reconnoitered for active burrows and traps set adjacent to burrow openings in order to identify species using the area but too far away from the transects to be captured during formalized sampling. This would take an additional 1-2 nights of trapping effort but would provide initial small-mammal occurrence data for the study site.

Detection of mid-sized carnivores could be facilitated by use of motion-sensing cameras. These, however, require maintenance over extended periods to be effective, hence do not lend themselves to application by consultants making short term visits to HTP. Ideally, the trading post might purchase one or two of these units and have post

personnel set and maintain them. Over time, these would provide new and interesting insights in the various more cryptic species using the site[2].

We observed bats feeding over Pueblo Colorado Wash during our nighttime amphibian surveys and found bat droppings near residential area and the visitor's center of HTP. A baseline inventory of bats feeding over the wash would allow monitoring of change of species and numbers of bats using the area as the vegetation recovers. Such a survey would require use of ultrasonic sensors by experienced bat specialists, mist netting, and/or harp netting over the wash (Kuntz, 1988).

Birds

February surveys produced the highest individual density but lowest species diversity of birds (Table 1). The high density of birds found in February suggests that the area is important for wintering birds. Nine species were recorded during the February counts that were not recorded during other seasons: pine siskin, Brewer's blackbird, crow, junco, red-tailed hawk, roadrunner, sharpshin, rufous-sided towhee, Townsend's solitaire. Of these, only the junco is strictly a wintering species for the area and unlikely to be detected any other time of year. The Brewer's blackbird and Townsend's solitaire may also increase in the area in the winter, but neither of these can be considered obligate to the habitats represented at the site. The pine siskin, recorded off-route in February, is more a species of conifer forests but may move to the lower elevation of the trading post during winter.

The May surveys produced the greatest bird species richness but was exceeded by the September survey for relative diversity and by the winter surveys for bird density.

[2] An excellent source of information in use of these cameras is Don Swann, biologist at Saguaro National Monument.

July surveys yielded the lowest density and diversity. Ideally, all four seasonal surveys should be maintained periodically if trends associated with vegetation recovery are to be detected. Those seasons experiencing low diversity of birds have the greatest potential to benefit from habitat changes associated with the stream improvement and might exhibit the greatest change over time.

Needed frequency of repetition of surveys is difficult to predict at this point. Logically, it should be keyed to some predetermined level of vegetational change, as detected by the established vegetation surveys, by obvious change in woody riparian vegetation, or by a specific hypotheses developed to be tested over time. At present, the inventory has the sole purpose of monitoring changes in bird, mammal and herptile populations over time as they relate to the vegetation and stream restoration project in progress on the study site. These efforts would become more directed if they were driven by a plan for wildlife species on the historic site with stated goals for particular species or species groups. On obvious possibility, given the low numbers of herptile, small mammal, ground-nesting birds, and owls, would be to focus upon improving habitat for these species. Such a plan would facilitate decisions on plantings and habitat improvement, along with criteria directing repetition of the various vertebrate surveys. results.

We evaluated the repetitive runs of bird routes within each period to determine if both days of survey effort were needed (table 7), hoping that survey effort within the survey periods could be reduced to one day. An average of 67.9 percent of all

species were seen on the first run on the first morning of surveys. The return run on the first morning added an average of only 3.7 percent of the species, but the second morning outgoing run added 18.7, and the return final run on the second morning added an average of 9.7 percent of species seen. Thus it seems essential that the full complement of survey runs be continued in future surveys. Considering that almost 10 percent of the species were first counted on the final runs, we recommend that the present survey level, at least, be sustained.

Reptiles and Amphibians

Both lizard and snake density and diversity seemed low on the area and we have no specific insights into cause or evaluations of methods. We can only recommend that these surveys be repeated after moisture conditions have improved and ground vegetation regrowth begins. Similarly, amphibian surveys should be repeated as the desired stream meanders and riparian growth become established.

A problem in surveying reptiles and, especially, amphibians lie in timing surveys when conditions are optimum. During May, we had good conditions (dry and warm) for lizard surveys, and, by chance, had relatively good conditions for amphibian surveys along the stream. Survey conditions for amphibians were enhanced by releases of moderate flows of irrigation water creating a wet streambed which apparently stimulated the toads to emerge. During July and, especially, September, conditions were less suitable, with afternoon and evening rains creating relatively high water flow in the stream through the night. Toad activity remained low, and negotiating the survey route became extremely difficult due to high water and deep mud.

Amphibian surveys could be improved if someone were available at HTP who could do toad surveys opportunistically when conditions were ideal. This would involve catching wet streambed with low stream-flow, perhaps after a receding flood or when only modest stream flow was occurring. Also, because timing and ambient conditions are important in doing such surveys, a series of surveys repeated through the summer would be more likely to catch peak conditions for the various species that might be present.

A definite methodological problem emerged in the time-constrained lizard surveys. Due to the sparseness of cover, we tended to move through the area at a relatively rapid rate. While making the surveys, we felt that we were spending excessive time and tended to spend less time in areas where we were seeing no lizards (Figure 3). This created a bias in the estimates of lizards/hour observed. If time constraint is to be used in future surveys, some method of breaking the long transect into uniform lengths and actually timing the rate of coverage will be required. However, the estimates of relative lizard density based upon a set transect width provide legitimate indices for comparing variation in lizard numbers between survey periods, as does the maximum lizards seen on a single run.

Species of Concern

Only four species noted during our surveys occur on any of the endangered species or species of concern lists. The kit fox is listed in Group 4 of the Navajo Endangered Species list. We did not confirm presence of this species in the study area, but on two occasions found small canid tracks that fell within the size range of kit fox. Further work would be needed to be sure that it is present. Lucy's warbler, greater

roadrunner, and sagebrush lizard appear on the Navajo Fish and Wildlife Elemental Tracking List. Lucy's warbler was seen as a fall migrant; the other three species are resident to the area.

General considerations and recommendations

The present survey has been designed to monitor birds, terrestrial mammals , reptiles, and amphibians as stream and vegetation characteristics change following stream improvement and exotic vegetation removal at HTP. The primary role of HTP is to preserve the historic ambience of the post. Within this framework, it is difficult to make specific recommendations for enhancing wildlife populations on the site. In reviewing both prehistoric and historic records, it appears that the site was heavily used by humans and their livestock early on. Domestic pets and livestock were very much a part of the historic scene, even prior to the establishment of the trading post. HTP undoubtedly now holds a higher density and diversity of wildlife species than it did during its first 100 years existence as a trading post.

A need exists for a vision statement and plan for wildlife that will interact with preservation of the historic character of the trading post site. Unlike most NPS properties, the objective for wildlife management cannot be to return to historic or presettlement conditions. Given the proximity of the site to Ganado, complete exclusion of domestic cats and dogs does not seem feasible. Thus an objective of sustaining the maximum diversity of wildlife species within the constraints of other uses of the site and its surroundings seems reasonable. The present efforts to improve ground level vegetation through soil stabilization, stream stabilization, and plantings adequately addresses such a goal. Special efforts should be made to create a good mix of grasses and

forbs on the exotic tree removal areas. This would provide food and cover for small terrestrial mammals, reptiles, and ground-nesting birds. Increase of these wildlife classes would attract both diurnal and nocturnal raptors, as well as snakes.

The present stream improvement program will continue to improve habitat for amphibians and semi-aquatic snakes. Diversity of toads, frogs, and snakes species should increase as the stream develops. Management of the stream to benefit leopard frogs may be worth exploring. Conceivably this species or other desirable native species appropriate to the developing habitat could be imported to speed their establishment in the area.

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